NEW HAMPSHIRE DIVISION OF HISTORICAL RESOURCES
State of New Hampshire, Department of Cultural Resources 603-271-3483
19 Pillsbury Street, 2nd floor, Concord NH 03301-3570 603-271-3558
Voice/ TDD ACCESS: RELAY NH 1-800-735-2964 FAX 603-271-3433
http://www.nh.gov/nhdhr preservation@nhdhr.state.nh.us

REPORT ON AN INSPECTION OF THE FIRST CHURCH OF CHRIST, SCIENTIST 33 SCHOOL STREET CONCORD, NEW HAMPSHIRE

JAMES L. GARVIN
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This report is based on an inspection of the church building on February 2, 1998. The purpose of the inspection was to discuss some of the structural and mechanical systems of the building and to make recommendations on future maintenance and preservation of the structure in ways that will preserve its historical significance and integrity.

Summary:

The building of the First Church of Christ, Scientist, in Concord was built in 1903-4 under the impetus of a gift of $100,000 from Mary Baker Eddy. The Boston architectural firm of Francis R. Allen and Charles Collens designed the church. Designed in a modified Gothic style, the structure is built of Concord granite. It incorporated the finest of materials and the most advanced heating and lighting technology available at the turn of the twentieth century. The building remains in original condition and has been well maintained. As the structure approaches a century in age, however, some of its original systems are showing deterioration and need to be refurbished or replaced.

The following pages discuss briefly the various subjects that are of current concern to the church.

General care of the building:

The church has made a conscientious effort to maintain the building over the years. In recent years, special efforts have been made to maintain the roofs and walls of the structure. Leakage had occurred through ice dams at the eaves or through damage to slates on the roof, and special efforts have been made to repair the roof surfaces and keep them in repair. Maintenance of a tight roof is the first and most essential step in maintaining any building.

Several questions arose during our meeting on the proper methods of maintaining a historic building, and on whether certain changes to the building might reduce its historical or architectural significance. There is no single set of rules for the maintenance of a historic building, but there are general guidelines or approaches that have been found to be helpful in approaching the upkeep or repair of any historic structure. These approaches have been codified into a set of guidelines called the *Secretary of the Interior's Standards for Rehabilitation*. These *Standards* are guidelines, not rules. They are intended to be applied flexibly, and with reference to the particular situation of a given building and the means available for its maintenance or rehabilitation. Although all federally-funded rehabilitation projects involving historic buildings are evaluated carefully with respect to the *Standards*, the same guidelines are useful in the care of any historic structure.

The ten *Secretary of the Interior's Standards for Rehabilitation* are:

1. A property shall be used for its historical purpose or shall be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.

2. The historical character of a property shall be retained and preserved. The removal of historical materials, or the alteration of features, spaces, and spatial relationships that characterize a property, shall be avoided.

3. Each property shall be recognized as a physical record of its time, place, and use. Alterations that create a false sense of historical development, such as adding conjectural features or elements taken from other historical buildings, shall not be undertaken.

4. Most properties change over time. Changes to a property that have acquired historical significance in their own right shall be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques, or examples of craftsmanship that characterize a property, shall be preserved.

6. Deteriorated historical features shall be repaired rather than replaced. Where the severity of deterioration requires the replacement of a distinctive feature, the new feature

shall match the old in design, scale and proportion, color, texture, and, where possible, in materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

7. Chemical or mechanical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historical materials shall not be used.

8. Archaeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alterations, or related new construction shall not destroy historical materials, features, and spatial relationships that characterize a property. New work shall be differentiated from the old, and shall be compatible with the massing, size, scale, and architectural features of the historical property so as to protect the integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historical property and its environment would be unimpaired.

It is clear that the First Church of Christ, Scientist, in Concord has adhered to the spirit of the relevant *Standards* in past upkeep of the church building. The *Standards* may be a useful point of reference for future work.

Heating and insulation:

Existing systems: The church building is heated by steam, arranged in a combined direct-indirect system. Direct heating occurs in those areas where steam is delivered directly to radiators, which warm their respective rooms through a combination of radiation and convection. Indirect heating occurs in those areas where radiators are enclosed in heat boxes or plenums in the church basement, and where air is delivered to those plenums and then passes into the rooms above.

Indirect heating is primarily confined to the sanctuary area. The effectiveness of the indirect system is enhanced by a system of ducts in the basement, connected to a large centrifugal fan which draws outside air through intakes on the School Street side of the building. The fan draws this air through a pre-heater room adjacent to the blower, where it is warmed initially, and then delivers the warmed air through ducts to the plenums at various locations in the basement. Within the plenums, the air is heated to its full required temperature and delivered to key points. Among those key points are the bottoms of the window embrasures, where the forced warm air counteracts the downward currents of chilled air from the cold glass.

A few of the floor registers in the sanctuary are connected to plenums in the basement that have open bottoms and are not connected to the blower and air ducts. These plenums draw air from the dirt-floored cellar, where it passes over the radiators in the plenums and then rises into the sanctuary by simple convection. These open-bottomed plenums may draw a certain amount of dust from the dirt-floored cellar into the auditorium.

The system may be (and usually is) run strictly by convection, without the fan. The fan may also be run in hot weather to draw cooler night air into the building.

It is usual for a turn-of-the-century direct-indirect steam heating system like this to have outlets at the top of the building for exhausting air when the fan is running. Without such outlets, the fan builds up internal pressure in the building and cannot draw air into the structure to the blower's full capacity. When used to cool the building in the summertime, the fan also needs such outlets to force accumulated warm air out of the building.

Present-day fuel costs make it commonplace for the fans and roof vents of such systems not to be operated in cold weather, since such systems are designed to draw cold air into the building, heat it, and then exhaust a portion of the heated air out of the top of the building. On the other hand, it is sometimes found to be desirable to run the fan on summer nights to cool a building. In such cases, it is important to determine how the air is intended to be exhausted from the top of the building.

We did not investigate the exhaust system of the church. Mr. Barton mentioned an air space between the sanctuary ceiling and the church roof, and this space may connect to a warm air outlet. The stone tower of the church may also have been designed to serve as a warm air outlet. The original design should be studied before any attempt is made to insulate the space between the sanctuary ceiling and to roof. While the fan may never again be run in cold weather, it may be desirable to use it to cool the building in warm weather. In such a case, it will be important to know how to exhaust the hot summer air from the top of the structure and to keep the exhaust system operable.

The steam system of the church building is a one-pipe system in which steam is delivered to radiators through a single pipe, and condensate is returned from the radiators through the same pipe. The system has three zones: the sanctuary, the office area at the rear of the church, and the Sunday school building. Whereas the church would originally have been heated by a boiler in the basement, Concord Steam Corporation now supplies steam to the building.

Our discussion focused on means to reduce the heating costs for the building. The church is now kept heated to a more-or-less uniform temperature during the cold months. Fuel bills fluctuate from winter to winter, depending upon the number of heating degree-days of a given winter season.

It has been suggested that the control and efficiency of the steam heating system could be improved by converting the system from a one-pipe to a two-pipe system. A two-pipe steam system allows for the installation of automatic valves and regulating thermostats at many points in a building, permitting much more delicate or balanced control of the heating and allowing some areas of the building to be kept at a lower temperature than others, if desired.

(more on historical impact, etc., of conversion.)

Humidification: On the recommendation of consultants, efforts are made to deliver humidity to the church organ. This humidification is largely accomplished by drawing outside air into a central room at the rear (west) of the basement, and by humidifying this room. The humid air from this room passes up into the organ through the chamber where the organ blowers are located.

Beyond this, no attempt is made to control the humidity elsewhere in the building. Organ consultants have evidently expressed concern over the generally low level of relative humidity of the organ chamber, but it appears that no actual record of the relative humidity in the building, or in the organ area, has been kept during a heating season. At present, therefore, humidification is being supplied to the building, but its distribution and its ultimate effects, beneficial or harmful, have not been assessed fully.

There is a possibility that the humidification now being supplied to the building for the benefit of the organ is having negative effects elsewhere. Mr. Barton mentioned the fact that the inside of the masonry walls of the tower are sometimes coated with frost in the winter. This indicates that humid air is finding its way into the tower, and that the humidity in the air is condensing and freezing on the inside faces of the walls.

In general, there is a danger of harm whenever frost occurs on the insides of the outer walls of a building. It is possible that some of the past damage to the stone tower and its wooden framing can be attributed to condensation of humid air within the tower as well as to rainwater penetration through the walls of the tower. We did not inspect the tower, so this report cannot assess its condition during cold weather.

If frost occurs on the cold stonework within the tower, however, it may also be occurring on the insides of the masonry walls of the building, hidden within the air space between those masonry walls and the lath and plaster of the inner walls. Humidity within a building is capable of penetrating many materials, including painted wall plaster. Humidity always migrates from areas of higher concentration to areas of lesser concentration. In the wintertime, the warm air within a structure is usually laden with relatively high amounts of water vapor, especially if the structure has a source of water such as the humidifier that is kept running in the church for the benefit of the organ. The water vapor in this inside air is constantly moving toward an area of lesser humidity, and in the winter that area of lesser humidity is the cold, dry outside air.

As the water vapor from within the building migrates outward, it may encounter a colder zone within the building. There, the gaseous water vapor is cooled to the dew point, and condenses as liquid water. If the surface on which the water vapor condenses is cooler than 32 degrees F., the condensed water vapor forms frost. Since frost occurs within the belltower, it may also occur within the walls of the building.

If condensation does occur within the walls, it may in time cause the decay of any wooden members to which the lath and plaster are attached. If the plaster is applied over expanded metal lath (as it is in the porte-cochere), the moisture may cause the lath to rust and deteriorate.

If the condensed water runs down the hidden interior faces of the masonry walls of the building, it will eventually saturate the mortar joints between the granite stones or brick backing that lies behind the granite. This saturated mortar may freeze in cold weather and expand, damaging the adhesion of the masonry and possibly damaging the stones or bricks themselves.

For all of these reasons, it would be prudent to monitor the migration of humidity throughout the church building and examine the structure for evidence of condensation in out-of-the-way places. If condensation or frost is forming during cold weather, it will be especially important to reexamine and control the methods used to supply humidification to the organ.

There are two relatively simple methods of monitoring the relative humidity in the organ chamber and in other parts of the building. The first (and more expensive) would use one or more recording hygrothermographs to keep weekly records of temperature and relative humidity at various points. Attached to this report is information on such instruments. A second (and less expensive) method would be to use small hygrometer/thermometer units. Unlike the recording hygrothermographs, these less expensive units, costing perhaps $40 each, need to be read at regular intervals, and their information needs to be manually recorded on a chart.

Insulation: Questions about the level and migration of humidity within the church building can be answered only through monitoring over a period of time. These answers are connected to another issue of concern to the church membership: the control of heat loss from the building.

In general, it is advisable to minimize heat loss from any building, especially with the high fuel prices and diminishing worldwide fuel reserves of today. As noted above, the church building was not designed for great thermal efficiency. The original heating and ventilating system probably included a deliberate mechanical means of exhausting heated but stale air out of the top of the structure in the wintertime, an unthinkable luxury in this age of tight (and often over-tight) buildings.

Because thermal insulation was seldom utilized in buildings of the early part of the century, there is certainly considerable heat loss from the church building at present. This heat loss is clearly indicated by the formation of ice dams at the eaves of the structure, and by the columns of ice that form on the walls of the church beneath roof valleys. These ice conditions are caused by the escape of heat through the building's roof. This heat melts snow on the roof, and the meltwater runs down the roof to the colder eaves or down the walls of the building. There, the water freezes. If there were no heat loss through the roof membrane, this ice formation would not occur.

The building is protected against damage from ice dams by the installation of a sheet metal ice shield at the eaves. This prevents the water that accumulates behind an ice dam from backing up under the slates and finding its way into the building. But the fact that such leaks occurred before the ice course was widened proves that heat loss through the roof has been a chronic condition.

Heat loss from most buildings occurs primarily in two areas: through the roof, and through windows and doors. Heat loss through walls is usually a factor of lesser importance, and attempts to reduce heat loss through walls can be hazardous, as mentioned below. Therefore, the chief areas to consider in reducing heat loss in the church are its roof and its doors and windows.

Because there is a space between the ceiling of the sanctuary and the roof of the building, it may be possible to install insulation in this area. If this can be done without unintended harm to the building, such insulation should not only reduce fuel consumption, but should also minimize the formation of ice dams and the potential damage that ice can create.

On the other hand, it is possible that the area between the sanctuary ceiling and the building's roof was intended as a ventilating space to conduct air out of the top of the building when the blower is running. It will be important to understand the intended function of this space, and the effects of placing insulation over the ceiling membrane, before

Recommendations:

1. Employ a heating and ventilating engineer to study the design and operation of the heating and ventilating system of the church. It has already been suggested that the heating of the building can be better controlled and made more efficient through the conversion of the system from one-pipe steam to two-pipe steam.

2. Employ a conservator to monitor temperature, humidity, and condensation in the building over the course of a heating season.